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Apply Pesticides Correctly A Guide for Private Applicators

Department of Agriculture Extension Service, Washington, D C

Prepared for

Environmental Protection Agency, Washington, D C Pesticide Operations Div

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Apply Pesticides Correctly

A guide for private applicators

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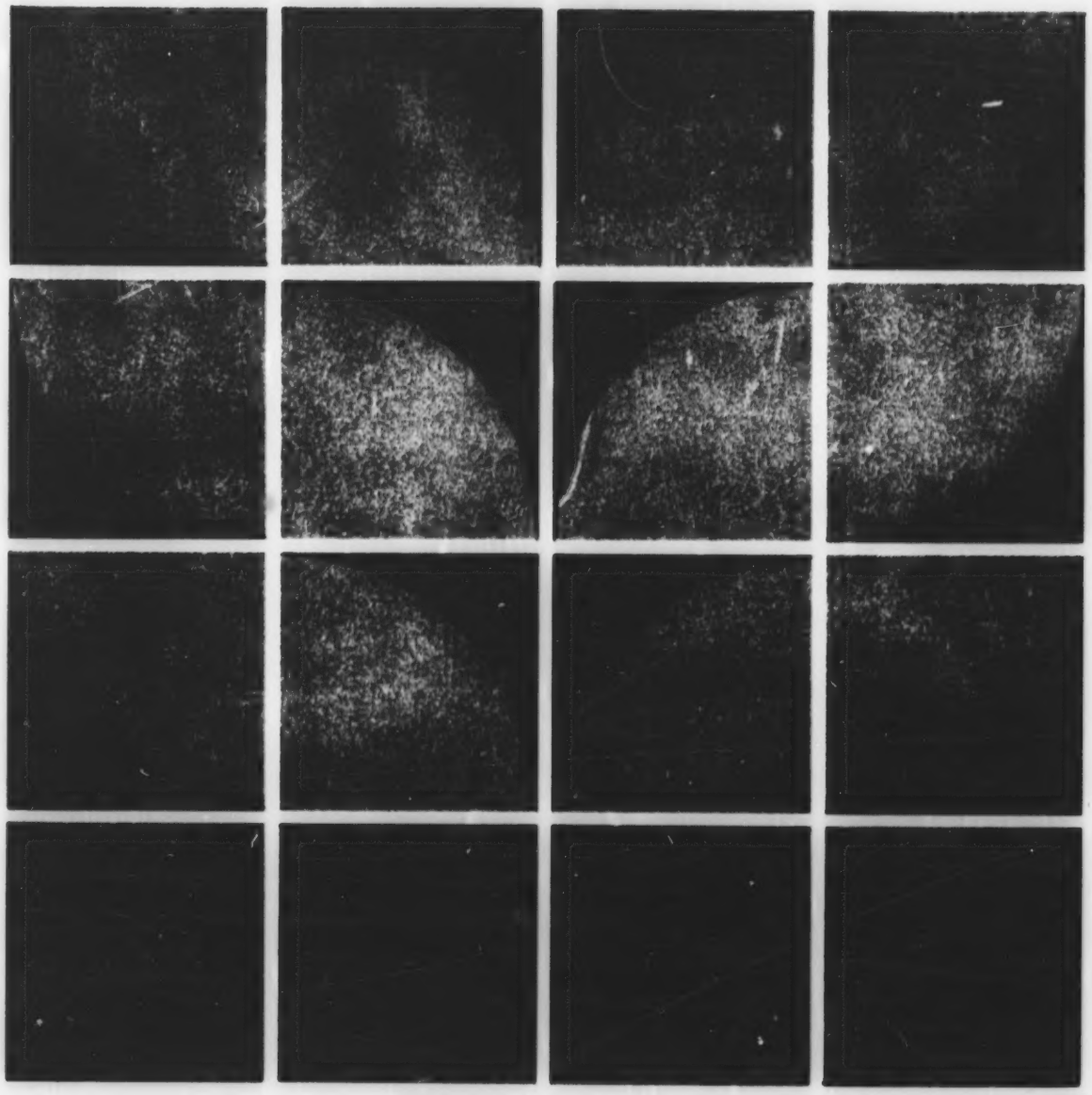

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Apply Pesticides Correctly

A guide for private applicators

Contents

Preface iii

Introduction iii

Pests 1-1
- Insects 1-1
- Mites, Ticks, and Spiders 1-1
- Snails and Slugs 1-1
- Pest Animals 1-1
- Weeds 1-1
- Plant Diseases 1-2

Pest Control 1-2

Pesticides 2-1
- How Pesticides Work 2-1
- Using Pesticides 2-2
- Types of Formulations 2-2

Labels and Labeling 3-1

Using Pesticides Safely 4-1
- How Pesticides Harm Man 4-1
  - Symptoms of Pesticide Poisoning 4-1
  - First Aid Procedures 4-1
  - Protecting Your Body 4-2
- How Pesticides Harm the Environment 4-3
- Safe Use Precautions 4-3

Application Equipment 5-1
- Sprayers 5-1
- Dusters and Granular Applicators 5-3
- Calibration 5-3

Laws and Regulations 6-1
- Federal Insecticide, Fungicide, and Rodenticide Act 6-1
- Residues 6-1

U.S. Environmental Protection Agency

U.S. Department of Agriculture

COLOR ILLUSTRATIONS REPRODUCED IN BLACK AND WHITE

Preface

This guide has been developed by the Pesticide Operations Division, U.S. Environmental Protection Agency (EPA), and the Extension Service, U.S. Department of Agriculture (USDA).

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Many other people contributed greatly to the book by reviewing it at various stages. They represent EPA, USDA, State regulatory agencies, the pesticide industry, environmental groups, and applicator associations.

Introduction

Federal regulations set minimum requirements that you must meet before you can use certain pesticides. This guide contains the practical information you need to prepare you to meet most of these requirements. It does not include all the things you need to know about the pests you wish to control. It may not include all the information you may be required to know to meet your State requirements. Your State Pesticide Regulatory Agency and your State Extension Service can give you this additional information.

This book will tell you:

- some features of common pests, how they develop, and the kinds of damage they do,
- methods you can use to control pests,
- how pesticides work,
- how pesticide labels can help you,
- how to use pesticides so they will not harm you or the environment,
- how to choose, use, and care for some equipment, and
- the Federal laws that apply to your use of pesticides.

Pests

Pests can be put into five main groups:

- insects (plus mites, ticks, and spiders),
- snails and slugs,
- pest animals,
- weeds, and
- plant disease agents.

You probably will find some pests that you cannot identify. Never try to control a pest until you are sure of what it is. Ask your Cooperative Extension agent. He will help you to get the correct answer.

Insects

Many kinds of insects are pests. They may:

- feed on leaves,
- tunnel or bore in stems, stalks, and branches,
- feed on and tunnel in roots,
- feed on and in seeds and nuts,
- suck the sap from leaves, stems, roots, fruits, and flowers,
- carry plant and animal disease agents, and
- feed on or in man and other animals.

All adult insects have two things in common—they have six jointed legs and three body regions. Almost all insects change in shape, form, and size during their lives.

You can tell one insect from another by looking at the *wings* and *mouthparts*. Some insects have no wings. Others have two or four. The wings vary in shape, size, thickness, and structure. Insects feed in different ways. Those with chewing mouthparts have toothed jaws that bite and tear the food. Insects with piercing-sucking mouthparts have a long beak which they force into a plant or animal to suck out fluids or blood.

Mites, Ticks, and Spiders

Mites, ticks, and spiders are closely related to insects. The main differences are that the adults have eight jointed legs instead of six and have two body regions. They do not have wings.

Snails and Slugs

Snails and slugs are members of a large group of animals called mollusks. Snails have a hard shell; slugs have no shell. They feed on plant foliage. They are pests in lawns, landscape plantings, and greenhouses.

Pest Animals

Fish, snakes, turtles, alligators, lizards, frogs, toads, salamanders, birds, and mammals may be pests. What may be a pest animal in some cases may be highly desirable in others.

Weeds

A weed is simply "a plant out of place." Before you can control weeds, you need to know something about how they grow. One important feature is the length of their life cycle.

Annuals

Plants with a one-year life cycle are *annuals*. They grow from seed, mature, and produce seed for the next generation in one year or less and then die.

Summer annuals are plants that result from seeds which sprout in the spring.

Winter annuals are plants that grow from seeds which sprout in the fall.

Biennials

Plants with a two-year life cycle are *biennials*. They grow from seed and develop a heavy root and a compact cluster of leaves the first year. In the second year they mature, produce seed, and die.

Perennials

Plants which live more than two years and may live indefinitely are *perennials*. During the winter many lose their foliage and the stems of others may die back to the ground. Some grow from seed. Others produce tubers, bulbs, rootlike below-ground stems or above-ground stems that produce roots.

Plant Diseases

A plant disease is any harmful condition that makes a plant different from a normal plant. There are two main kinds of plant diseases.

Diseases Caused by Non-Living Agents

The causes include such things as frost, air pollution, and drought. These diseases cannot be passed from one plant to another.

Diseases Caused by Living Things

The most common causes of these diseases and examples of the diseases they cause are:

- fungi (scabs and rot),
- bacteria (blights, wilts, and scabs),
- viruses (mosaics), and
- nematodes (root knots and cysts).

Some visible ways plants respond to disease causes are:

- galls, swellings, and leaf curls,
- stunting, lack of green color, and incomplete development of parts, and
- blights, leaf spots, wilting, and cankers.

Pest Control

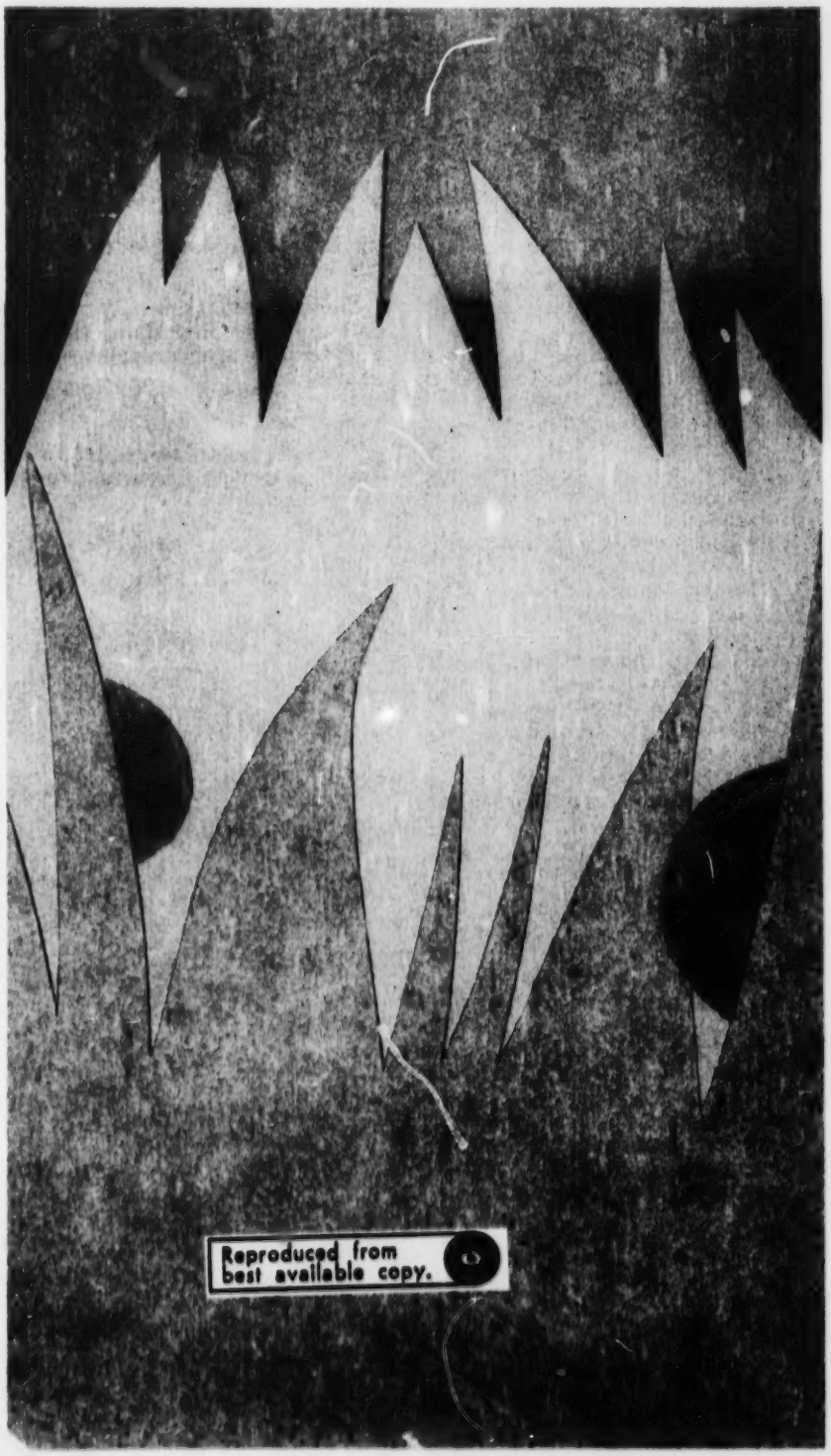
If you have identified a pest, and you know how it grows, spreads, and does its damage, you can begin to plan how to control it.

Using a pesticide is only one of many ways to control pests. The use of a combination of methods is basic to all pest control. Be sure to think about what other methods might work before you decide to apply a pesticide. You can minimize pest problems by:

- encouraging pests' natural enemies,
- planting crop varieties that resist pests,
- destroying crop residues,
- practicing good manure management,
- clean plowing and cultivation.

Pest control is necessary only when the pest is causing more damage than is reasonable to accept. Even though a pest is present, it may not do much harm. It could cost more to control the pest than would have been lost because of the pest's damage.

Pesticides



Here are the types and uses of pesticides:

Insecticide: controls insects and other related pests such as ticks and spiders.
Miticide: controls mites.
Acaricide: controls mites, ticks and spiders.
Nematicide: controls nematodes.
Fungicide: controls fungi.
Bactericide: controls bacteria.
Herbicide: controls weeds.
Rodenticide: controls rodents.
Avicide: controls birds.
Piscicide: controls fish.
Molluscicide: controls mollusks, such as slugs and snails.
Predacide: controls pest animals.
Repellent: keeps pests away.
Attractant: lures pests.
Plant Growth Regulator: stops, speeds up, or otherwise changes normal plant processes.
Desiccants and Defoliants: harvest-aid chemicals used to remove or kill leaves and stems.
Antitranspirant: Reduces water loss from plants.

How Pesticides Work

Pesticides can be grouped according to what they do. Many work in more than one way. Read the label to find out what the one you are using will do.

Some of the ways pesticides work are:
Contacts: kill pests simply by contacting them.
Stomach poisons: kill when swallowed.
Systemics: kill pests by being taken into the blood of the animal or sap of the plant upon which the pest is feeding.
Translocated herbicides: kill plants by being absorbed by leaves, stems, or roots and moving throughout the plant.
Fumigants: gases which kill

when they are inhaled or otherwise absorbed by the pest.
Selective: kills certain kinds of plants or animals.
Nonselective: kills most plants or animals.

Using Pesticides

Many terms describe when and how to use pesticides.

When To Use

Preemergence: used before crops or weeds emerge. May also refer to use after crops emerge or are established, but before weeds emerge.
Preplant: used before the crop is planted.
Postemergence: used after the crop or weeds have emerged.

How To Use

Band: application to a strip over or along each crop row.

Broadcast: uniform application to an entire, specific area.
Dip: complete or partial immersion of a plant, animal, or object in a pesticide.

Directed: aiming the pesticide at a portion of a plant, animal, or structure.
Drench: saturating the soil with a pesticide; oral treatment of an animal with a liquid pesticide.
Foliar: application to the leaves of plants.
In-furrow: application to or in the furrow in which a plant is planted.
Over-the-top: application over the top of the growing crop.
Pour-on: pouring the pesticide along the midline of the back of livestock.
Sidedress: application along the side of a crop row.
Soil incorporation: application to the soil followed by use of tillage implements to mix the pesticide with the soil.
Spot treatment: application to a small area.

Types of Formulations

Active ingredients
(the chemicals that do the work)
+
Inert ingredients
(make the product easier to apply)
=
Pesticide formulation

Here are the most common kinds of formulations. Labeling and Cooperative Extension Service recommendations may refer to them by these common letter abbreviations.

Liquid Formulations

Emulsifiable Concentrates (EC or E)

An emulsifiable concentrate can be mixed with water to form a emulsion in your spray tank.

Ultra Low Volume Solutions (ULV)

These formulations may contain only the active ingredient itself. They require special application equipment.

Solutions (S)

These formulations are ready to use. They are often used on livestock and in barns.

Flowables (F or L)

A flowable can be mixed with water to form a suspension in your spray tank.

Aerosols (A)

These are low concentrate solutions, usually applied as a fine spray or mist indoors. Some are sold in pressurized cans.

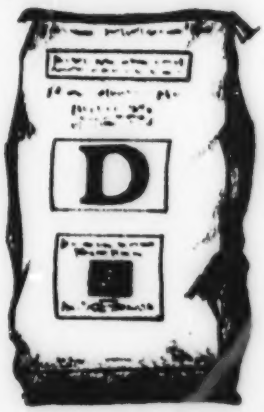
Liquified Gases

These fumigant formulations turn into a gas when they are applied. Some of them have to be packaged in pressure containers.

Dry Formulations

Dusts (D)

Dust formulations are made by adding the active ingredient to a fine inert powder. Dusts must be used dry.

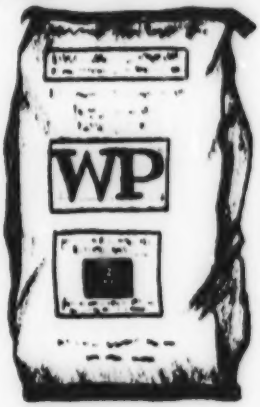


Granules (G)

Granular formulations are made by adding the active ingredient to coarse particles (granules) of some inert material. Granule particles are much larger than dust particles.

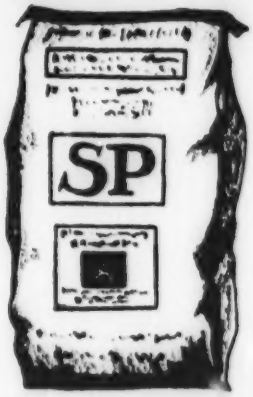
Wettable Powders (WP or W)

Wettable powder formulations are made by combining the active ingredient with a fine powder and a wetting agent. They look like dusts, but they are made to mix with water. These formulations need continuous agitation to maintain a suspension.



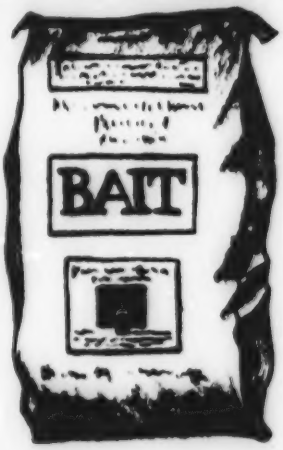
Soluble Powders (SP)

A soluble powder formulation is made from an active ingredient that dissolves in water.



Baits (B)

A bait formulation is made by adding the active ingredient to an edible or attractive substance.



PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS
(& DOMESTIC ANIMALS)

DANGER

ENVIRONMENTAL HAZARDS

PHYSICAL OR CHEMICAL HAZARDS

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling

RE-ENTRY STATEMENT
(If Applicable)

CATEGORY OF APPLICATOR

STORAGE AND DISPOSAL

STORAGE

DISPOSAL

CROP

RESTRICTED USE PESTICIDE

FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION

PRODUCT NAME

ACTIVE INGREDIENT: _____ %
INERT INGREDIENTS _____ %

TOTAL 100.00 %

THIS PRODUCT CONTAINS LBS OF PER GALLON

KEEP OUT OF REACH OF CHILDREN

DANGER — POISON

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED
IF INHALED
IF ON SKIN
IF IN EYES

SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS

MFG BY
TOWN, STATE
ESTABLISHMENT NO
EPA REGISTRATION NO

NET CONTENTS

CROP

CROP

CROP

CROP

CROP

WARRANTY STATEMENT

Labels and Labeling

All the printed information you get about a pesticide product from the company or its agent is called labeling. Labeling includes such things as:

- the label on the product,
- brochures,
- flyers, and
- other printed information handed out by your dealer.

The label is the information printed on or attached to a container of pesticides. The label will tell you:

- how to use the product correctly, and
- what special safety measures you should take.

Parts of the Label

Brand Name

Each company uses brand names to identify its products. The brand name shows up plainly on the front panel of the label.

Type of Formulation

Different types of pesticide formulations (such as liquids, wettable powders, and dusts) require different methods of handling. The label will tell you what type of formulation the package contains. The same pesticide may be available in more than one formulation.

Ingredient Statement

Every pesticide label must list what is in the product. It tells you the names and amounts of the active ingredients and the amount of inert ingredients.

Common Name

Many pesticides have complex chemical names. Some have been given another name to make them easier to identify. These are called *common names*. A chemical made by more than one company will be sold under several brand names, but you may find the same common name or chemical name on all of them.

Net Contents

The net contents number tells you how much is in the container. This can be expressed in gallons, pints, pounds, quarts, or other units of measure.

Name and Address of Manufacturer

The law requires the maker or distributor of a product to put the name and address of the company on the label. This is so you will know who made or sold the product.

Registration Number

A registration number must be on every pesticide label. It shows that the product has been registered with the Federal Government.

Establishment Number

The establishment number tells what factory made the chemical. This number does not have to be on the label, but will be somewhere on each container.

Precautionary Statements

Hazards to Humans (and Domestic Animals)

This section will tell you the ways in which the product may be poisonous to man and animals. It also will tell you of any special steps you should take to avoid poisoning, such as the kind of protective equipment needed.

If the product is highly toxic, this section will inform physicians of the proper treatment for poisoning.

Environmental Hazards

The label tells you how to avoid hurting the environment. Some examples are:

- "This product is highly toxic to bees exposed to direct treatment or to residues on crops."
- "Do not contaminate water when cleaning equipment or when disposing of wastes."
- "Do not apply where runoff is likely to occur."

Physical and Chemical Hazards

This section will tell you of any special fire, explosion, or chemical hazards that the product may have.

Signal Words and Symbols

Some pesticides may be hazardous to people. You can tell how toxic a product is by reading the *signal word* and *symbol* on the label.

Signal Words

Signal Words	Toxicity	Appromixate Amount Needed To Kill the Average Person
DANGER	Highly toxic	a taste to a teaspoonful
WARNING	Moderately toxic	a teaspoonful to a tablespoonful
CAUTION	Low toxicity or Comparatively free from danger	an ounce to more than a pint

All products must bear the statement "Keep out of reach of children."

Symbol

The skull and crossbones is used on all highly toxic materials along with the signal word DANGER and the word POISON.

Statement of Practical Treatment

If swallowing or inhaling the product or getting it in your eyes or on your skin would be harmful, the label will tell you emergency first aid measures. It also will tell you what types of exposure require medical attention.

The pesticide label is the most important information you can take to the physician when someone has been poisoned.

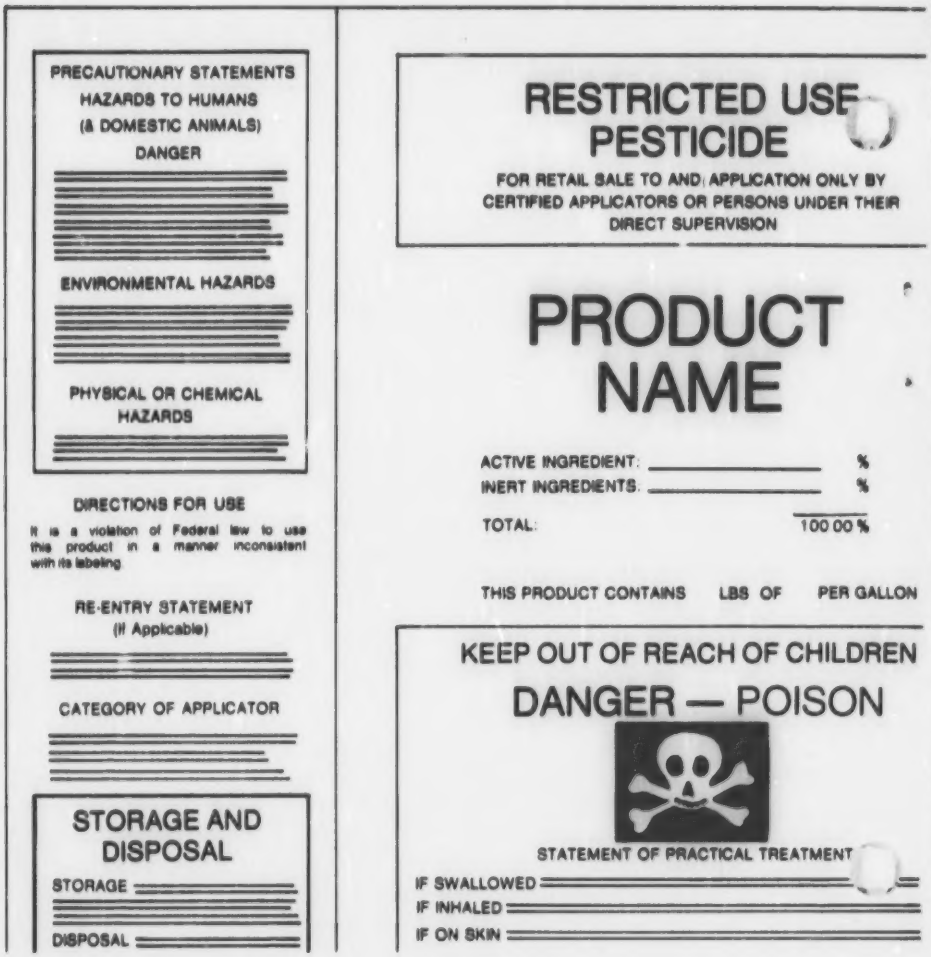
Statement of Use Classification

Every pesticide label must show whether the contents are for general use or restricted use. The label will say:

"General classification"

or

"Restricted use pesticide for retail sale to and application only by certified applicators or persons under their direct supervision."



Directions for Use

The directions for use tell you:

- the pests the product will control (If you cannot find a product that lists the pest you want to control, ask your dealer or Cooperative Extension agent. The label may use a different name for the pest than the one you use.),
- the crop, animal, or other item the product can be used on,
- whether the product is for general or restricted use,
- how the product should be applied,
- how much to use,
- where the material should be applied, and
- when it should be applied.

Misuse Statement

This section will remind you that it is a violation of Federal law to use a product in a manner inconsistent with its labeling.

Reentry Statement

If required for the product, this section will tell you how much time must pass before a pesticide-treated area is safe for entry by a person without protective clothing. Consult local authorities for special rules that may apply.

Category of Applicator

If required for the product, this section will limit use to certain categories of commercial applicators.

Storage and Disposal Directions

Every pesticide should be stored and disposed of correctly. This section will tell you how to store and dispose of the product.

Do not use a product on a crop or for a pest not listed on the label. Always use it at the recommended rate.

Using Pesticides Safely

There are two good reasons for using pesticides safely:

- to keep yourself and other people from being poisoned, and
- to avoid harming the environment.

How Pesticides Harm Man

Most pesticides can cause severe illness, or even death, if misused. But every registered pesticide can be used safely if you use it correctly.

Many accidental pesticide deaths are caused by eating or drinking the product. But some applicators die or are injured when they breathe a pesticide vapor or get a pesticide on their skin. Repeated exposure to small amounts of some pesticides can cause sudden severe illness.

To prevent *all* accidents with pesticides you should:

- use and store pesticides away from children and other untrained persons,
- keep pesticides in their original containers, and
- take care to follow directions when using them.

Products for restricted use require special handling. The label is your guide.

Symptoms of Pesticide Poisoning

You should know the kinds of sickness that are caused by the pesticides you use.

Get medical advice quickly if you or any of your workers get sick during or after pesticide use. If you think a person may be poisoned, do not leave him alone. Do not let yourself or anyone else get dangerously sick before calling a physician or going to a hospital.

Take the container (or the label) of the pesticide with you. Do not carry a pesticide container in the passenger space of a car or truck.

It is better to be too cautious than too late.

Parathion and Similar Pesticides (Organophosphates and Carbamates)

These pesticides injure the nervous system. The symptoms develop in stages. They usually occur in this order:

Mild Poisoning

- fatigue
- headache
- dizziness
- blurred vision
- too much sweating and salivation
- nausea and vomiting
- stomach cramps or diarrhea

Moderate Poisoning

- unable to walk
- weakness
- chest discomfort
- muscle twitches
- constriction of pupil of the eye
- earlier symptoms become more severe

Severe Poisoning

- unconsciousness
- severe constriction of pupil of the eye
- muscle twitches
- secretions from mouth and nose
- breathing difficulty
- death if not treated.

Illness may occur a few hours after exposure. But if symptoms start more than 12 hours after you were exposed to the pesticide, you probably have some other illness. Check with your physician to be sure.

Several other pesticides may cause symptoms similar to these.

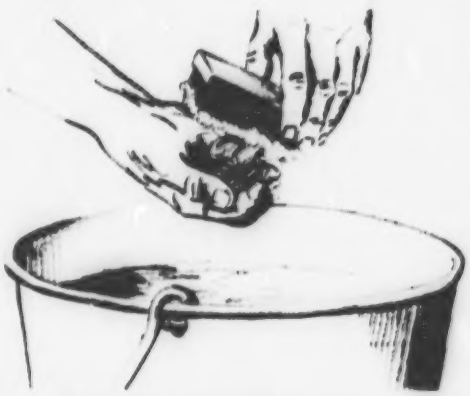
Fumigants and Solvents

Too much exposure to these chemicals may make a person appear drunk. The symptoms are:

- poor coordination,
- slurring words,
- confusion, and
- sleepiness.

First Aid Procedures

Read the "Statement of Practical Treatment" on each label. The directions listed can save your life and the lives of your family and your workers.



If you get a pesticide on your skin:

- Remove the pesticide as quickly as possible. Remove all contaminated clothing. Prompt washing may prevent sickness even when the spill is very large. Detergents work better than soap in removing pesticides. Don't forget your hair and fingernails.

If you inhale a pesticide:

- Get to fresh air right away.

If you splash a pesticide into your mouth or swallow it:

- Rinse your mouth with several glasses of water.
- Go or be taken to a physician immediately.
- It is sometimes dangerous to cause vomiting; follow label directions.

If a person has been poisoned, do not leave him alone.

In addition, remember to bathe, using a detergent, when you finish working with pesticides or pesticide-contaminated equipment. Any time you spill a pesticide on yourself, wash immediately.

Protecting Your Body

The label of each pesticide you use will tell you the kind of protection you need.

Protective Clothing

Body Covering—In general, any time you handle pesticides, you should wear:

- a long-sleeved shirt and long-legged trousers, or
- a coverall type garment.

Clothing should be made of closely woven fabric. When you handle pesticide concentrates or very toxic materials, also wear a liquid-proof raincoat or apron. Trousers should be *outside* of the boots to keep pesticides from getting inside.

Gloves—Gloves should be long enough to protect your wrist. They should be made of neoprene and not lined with a fabric. Never use cotton or leather gloves unless the label tells you to. Sleeves should be *outside* of the gloves to keep pesticides from running down the sleeves and into the gloves.

Hat—Always wear something to protect your head. A wide-brimmed, waterproof hat will help protect your head, neck, eyes, mouth, and face. Wide-brimmed plastic "hard hats" are good. They are waterproof and easy to clean and are cool in hot weather. A plastic sweatband is best.

Boots—Wear unlined neoprene boots. Do not use leather or canvas boots unless the label tells you to.

Goggles or Face Shield—Wear goggles or a face shield when handling pesticides to avoid getting pesticides in your eyes.

Care of Clothing—Wear clean clothing daily. If clothes get wet with spray, change them right away. If they get wet with pesticide concentrates or highly toxic pesticides, destroy them. They are hard to get clean in normal home laundering. Never store or wash pesticide contaminated clothing with the family laundry. Wash hats, gloves, and boots daily. Test gloves for leaks by filling them with water and gently squeezing.

Wash goggles or face shields at least once a day. Elastic fabric headbands absorb pesticides. Use neoprene headbands.

Respiratory Protective Devices

You *must* wear an approved respiratory device when the label directs you to do so. Follow the label instructions on respiratory protection.

Chemical Cartridge Respirators—These half-face masks cover the mouth and nose.

Chemical Canister Respirators (Gas Masks)— Canister respirators cover your face. When correctly fitted they protect the face better than cartridge respirators.

Do not use either cartridge or canister respirators for protection during space fumigation or when the oxygen supply is low. Use special breathing devices as directed on the label.

Selection and Maintenance— Be sure you choose a respirator that is made to protect against the pesticides you use. Use only those approved by the National Institute for Occupational Safety and Health (NIOSH) or the Mining Enforcement and Safety Administration (MESA).

The respirator you choose must fit your face. Long sideburns, a beard, or glasses can prevent a good seal.

Read the manufacturer's instructions on the use and care of any respirator and its parts before you use it.

When applying pesticides, change cartridges and canisters if you have trouble breathing or if you smell pesticides. After use, remove and dispose of them as you would excess pesticides. Wash the face piece with detergent and water, rinse it, and dry it with a clean cloth after each use. Store your respirator in a clean, dry place away from pesticides. If you have trouble breathing while wearing a respirator, see your physician to find out if you have a respiratory problem.

How Pesticides Harm the Environment

Here are some ways damage can occur.

Direct Kill

Fine mists of herbicide can drift to nearby crops or landscape plants and kill them. You can kill bees and other pollinators if you treat a crop with a pesticide while they are in the field. Or you could kill the natural enemies of pest insects.

Life in streams or ponds can be wiped out by:

- accidental spraying of ditches and waterways.
- runoff from sprayed fields,
- careless tank filling or draining, or
- careless container disposal.

If more than one pesticide will control the pest, choose the one that is the least hazardous to the environment and most useful for your situation. Ask your Cooperative Extension agent to help you make this choice.

Persistence and Accumulation

Not all pesticides act the same after you apply them. Most are in one of these two groups:

Pesticides that break down quickly remain in the environment only a short time before being changed into harmless products.

Pesticides that break down slowly may stay in the environment without change for a long time. They are called *persistent pesticides.*

Some persistent pesticides can build up in the bodies of animals, including man. These pesticides are called *accumulative.*

Pesticide Movement in the Environment

Pesticides become problems when they move off target. This may mean:

- drifting out of the target area in the form of dust or mist,
- moving on soil particles by erosion,
- leaching through the soil,
- being carried out as residues in crops and livestock, or
- evaporating and moving with air currents.

Safe Use Precautions

You can prevent harm from pesticides if you follow safety precautions and use common sense. Here are the *minimum* safety steps you should take.

Before You Buy a Pesticide

The first and most important step in choosing a pesticide is to know what pest you need to control. Then find out which pesticides will control it. You may have a choice of several. Ask your dealer or Cooperative Extension agent to help you.

At the Time of Purchase

Read the label of the pesticide you intend to buy to find out:

- restrictions on use,
- if this is the correct chemical for your problem,
- if the product can be used safely under your conditions,
- environmental precautions needed,
- if the formulation and amount of active ingredient are right for your job,
- if you have the right equipment to apply the pesticide,
- if you have the right protective clothing and equipment, and
- how much pesticide you need.

Before You Apply the Pesticide

Read the label again to find out:

- the protective equipment needed to handle the pesticide,
- the specific warnings and precautions,
- what it can be mixed with,
- how to mix it,
- how much to use,
- safety measures,
- when to apply to control the pest and to avoid illegal residues,
- how to apply,
- the rate of application, and
- special instructions.

Transportation of Pesticides

You are responsible for the safe transport of your pesticide.

- The safest way to carry pesticides is in the back of a truck. Fasten down all containers to prevent breakage and spillage.
- Keep pesticides away from food, feed, and passengers.

- Pesticides should be in their original labeled packages. Keep paper and cardboard packages dry.
- If any pesticide is spilled in or from the vehicle, clean it up right away. Use the correct cleanup method.
- Do not leave unlocked pesticides unattended. You are responsible if accidents occur.

Pesticide Storage

The label will tell you how to store the product.

The storage place should keep the pesticides dry, cool, and out of direct sunlight.

The storage place should have:

- fire-resistant construction, including a cement floor,
- an exhaust fan for ventilation,
- good lighting, and
- a lock on the door.

Keep the door locked when the building is not in use.

Store all pesticides in the original labeled containers.

Do not store them with food, feed, seed, or animals.

Check every container often for leaks or breaks. If one is damaged, transfer the contents to a container that has held *exactly* the same pesticide. Clean up any spills. Use correct cleanup methods.

Mixing and Loading Pesticides

Keep livestock, pets, and people out of the mixing and loading area.

Work outdoors. Do not work alone. Choose a place with good light and ventilation. Do not mix or load pesticides indoors or at night unless there is good lighting and ventilation.

Before handling a pesticide container, put on the correct protective clothing and equipment.

Each time you use a pesticide, read the directions for mixing. Do this before you open the container. *This is essential.* Directions, including amounts and methods, may have changed since you last used the product.

When taking a pesticide out of the container, keep the container and pesticide below eye level. This will avoid a splash or spill on your goggles or protective clothing.

If you splash or spill a pesticide while mixing or loading:

- stop right away.
- remove contaminated clothing.
- wash thoroughly with detergent and water. *Speed is essential.*
- use correct cleanup methods to clean up the spill.

When mixing pesticides, measure carefully. Use only the amount called for on the label. Mix only the amount you plan to use.

When loading pesticides, stand so the wind blows across your body from the right or left to avoid contaminating yourself.

To prevent spills, replace all pour caps and close containers after use.

Pesticide Application

Wear the protective clothing and equipment the label requires.

To prevent spillage of chemicals, check all application equipment for:

- leaking hoses, pumps or connections, and
- plugged, worn, or dripping nozzles.

Use water to calibrate your spray equipment before use.

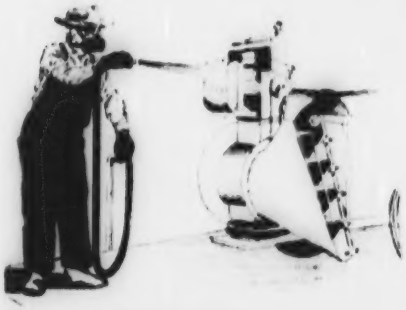
Before starting a field application, clear all livestock and people from the area to be treated.

Drift is the movement of spray droplets or dust particles away from the target area. To minimize drift, apply pesticides only on days with light breezes. If moderate to strong winds come up while you are working, stop immediately.

You also can reduce drift by spraying at the lowest practical pressure and using the largest practical nozzle openings for the job you are doing.

Vaporization is the evaporation of an active ingredient during or after application. Pesticide vapors can cause injury far from the site of application. High temperatures increase vaporization. You can reduce vaporization by:

- choosing pesticide formulations that do not evaporate easily, and
- spraying in the cooler parts of the day.



Cleaning Equipment

Mixing, loading, and application equipment must be cleaned as soon as you finish using it. Clean both the inside and outside. Wear the protective clothing you would wear for mixing pesticides.

Take special care if you must make equipment repairs before the equipment is completely cleaned.

Have a special area for cleaning. It is best for the area to have a wash rack or concrete apron with a good sump. This will catch all contaminated wash water and pesticides. Dispose of sump wastes by burning or burial as you would excess pesticides. Keep drainage out of water supplies and streams.

Disposal

Excess Pesticides

If you have excess diluted pesticides or pesticides in their original containers:

- Use them up according to label directions; if you cannot,
- bury them in a special landfill or store them until you can.

Empty Containers

Rinse and drain all metal, plastic, or glass containers this way:

1—Empty the container into the tank. Let it drain an extra 30 seconds.
2—Fill it one-fifth to one-fourth full of water.
3—Replace and tighten the closure and shake the container. Upend the container so the rinse reaches all the inside surfaces.
4—Drain the rinse water from the container into the tank. Let the container drain for 30 seconds after emptying.
5—Repeat steps 2, 3, and 4 two more times.

You can bury rinsed containers singly in open fields. Puncture or break the containers before burying them. Bury them at least 18 inches below the surface where they will not pollute surface or subsurface water. Or you can dispose of empty rinsed containers in a sanitary landfill. Check state and local regulations.

You may burn small numbers of paper containers in open fields. Stay out of fumes and smoke. Be sure your state and local regulations permit open burning.

Cleanup of Spills

Keep people away from spilled chemicals.

If the pesticide was spilled on anyone, give the correct first aid.

Confine the spill. Dike it up with sand or soil if necessary.

Use an absorbent material to soak up the spill. You can use soil, sawdust, or a special product made to do this. Shovel all contaminated material into a leakproof container for disposal. Dispose of it in a special landfill.

If the spill is on a state highway, call the highway patrol.

If the spill is on a county road or a city street, call the county sheriff or city police.

If water is contaminated, notify your county health officials.

Safe Entry Times

It may be dangerous for an unprotected person to enter an area immediately after some pesticides have been used. The time that must pass before the area is safe for a person without protective clothing is called a safe-entry time, or reentry period. This time is given on the label of each pesticide that may cause a reentry problem. Reentry may pose special problems in some areas. Check with local authorities for any special rules that may apply.

Application Equipment

The pesticide application equipment you use is important to the success of your pest control job. You must first select the right kind of equipment. Then you must use it correctly to suit your needs and take good care of it. Here are some things you should know about choosing, using, and caring for equipment.

Sprayers

Hand Sprayers

Hand sprayers are for small jobs around the farm and home. You can use them in restricted areas where a power sprayer would not work.

Advantages:

- economical,
- simple, and
- easy to use, clean, and store.

Limitations:

- may give an uneven application rate because of hand operation, and
- lack agitation and screening for using wettable powder formulations. You must shake the sprayer often to provide agitation.

Low Pressure Field Sprayers

Most of these sprayers are used for treating field and forage crops, pastures, and fence rows. They also may be used to apply fertilizer-pesticide mixtures.

Advantages

- medium to large tanks,
- low cost,
- light weight, and
- versatility.

Limitations

- low gallonage output limits their use when high volume is needed,
- low pressure limits pesticide penetration, and
- agitation is limited.

High Pressure Sprayers

These are often called hydraulic sprayers. They are designed to deliver high volumes (100 or more gallons per acre) at high pressure (above 100 psi). They are used to spray fruits, vegetables, landscape plants, and livestock.

Advantages:

- well built,
- usually have mechanical agitation,
- durable.

Limitations:

- high cost,
- large amounts of water, power, and fuel needed,
- high tire loads, and
- high pressure which makes a spray that drifts easily.

Air Blast Sprayers

These units use a high speed airstream to break up the nozzle output into fine drops which move with the airstream to the target. The air is directed to either one or both sides as the sprayer moves forward.

Advantages:

- good coverage and penetration,
- low pump pressures, and
- mechanical agitation.

Limitations:

- drift hazards,
- chance of overdosages,
- difficult to use in small areas, and
- hard to confine spray discharge to specific target.

Ultra Low Volume (ULV) Sprayers

Deliver undiluted special pesticide formulations. High speed airstreams may be used to break up and direct the spray.

Advantages:

- no water is needed, and
- equal control with less pesticide.

Limitations:

- does not provide for thorough wetting,
- hazards of using high concentrates,
- chance of overdosage, and
- small number of pesticides that can be used this way.

Nozzles

There are five basic nozzle types. All other types are variations. They are:

Solid Stream—A single jet used in handguns to spray a distant target or fixed in a nozzle body to apply a narrow band or to inject into the soil.

Flat Fan—This type has three different variations:

- The regular flat fan nozzle makes a narrow oval pattern with lighter edges. It is used on booms for broadcast spraying and is designed to be overlapped 30–50 percent for even distribution.

- The even flat fan nozzle makes a uniform pattern across its width. It is used for band spraying and for spraying walls and other surfaces.

- The flooding nozzle makes a wide-angle flat spray pattern. It works at lower pressures than the other flat fan nozzles. Its pattern is fairly uniform across its width. It is used for broadcast spraying.

Hollow Cone—This nozzle forms a pattern that is circular with tapered edges and little or no spray in the center. It is used for spraying foliage. There are two types of hollow cone nozzles:

- the core and disk, and
- the whirl chamber.

Solid Cone—This nozzle forms a circular pattern. The spray is well-distributed throughout the pattern. It is used for spraying foliage.

Broadcast—This nozzle forms a wide flat fan pattern. It is used on boomless sprayers and to extend the effective swath width when attached to the end of a boom.

You can get nozzles in many materials. Here are the main features of each kind.

Brass:
- Inexpensive,
- Wears quickly from abrasion,
- Probably the best material for limited use.

Stainless Steel:
- Will not corrode,
- Resists abrasion, especially if it is hardened,
- Probably the best material for extensive use.

Plastic:
- Resists corrosion and abrasion,
- Swells when exposed to some solvents.

Aluminum:
- Resists some corrosive materials,
- Is easily corroded by some fertilizers.

Tungsten Carbide and Ceramic:
- Highly resistant to abrasion and corrosion,
- Expensive.

Use and Care of Nozzles

Use nozzles of uniform type and size. Nozzle caps should not be over-tightened. Adjust nozzle height and spacing to suit the target. Follow the nozzle manufacturer's instructions and the directions on the pesticide label.

Replace any nozzles having faulty spray patterns.

Check each nozzle for uniform flow using water and a jar marked in ounces. Replace any with flow 5 percent more or less than the average of the nozzles in the system.

Clean nozzles only with a toothbrush or wooden toothpick.

Operation and Maintenance

Always read and follow the operator's manual. It will tell you how to use and care for your sprayer. Always drain and rinse your sprayer after each use. Check for leaks before and during use. Be alert for nozzle clogging and changes in nozzle patterns.

If nozzles clog or other trouble occurs in the field, shut off the sprayer and move it to the edge of the field before dismounting to correct the problem. Wear protective clothing while making repairs.

Store sprayers properly after use. But first, rinse and clean the system. Then fill the tank almost full with clean water. Add a small amount of new light oil to the tank. Coat the system by pumping tank contents out through the nozzles. Drain the pump and plug its openings or fill the pump with light oil or antifreeze. Remove nozzles and nozzle screens and store in light oil or diesel fuel.

Dusters and Granular Applicators

Hand Dusters

Like hand sprayers, hand dusters are used mainly around homes and in gardens. They may consist of a squeeze tube or shaker, a sliding tube, or a fan powered by a hand crank.

Advantage:

- the pesticide is ready to apply.

Limitations:

- high cost for pesticide,
- hard to get good foliar coverage, and
- dust is subject to drifting.

Power Dusters

Power dusters use a powered fan or blower to propel the dust to the target. They range from knapsack types to those mounted on or pulled by tractors.

Advantages:

- simply built,
- easy to maintain, and
- low in cost.

Limitations:

- drift hazards,
- high cost of pesticide, and
- application may be less uniform than sprays.

Granular Applicators

These include:

- hand-carried spinning disk types for broadcast coverage,
- mounted equipment for applying bands over the row in row crops, and
- mounted or tractor-drawn machines for broadcast coverage.

Advantages:

- eliminates mixing,
- is low in cost, and
- minimizes drift.

Limitations:

- high cost for pesticide,
- limited use against some pests because granules won't stick to most plants

Use and Maintenance

Dusters and granular applicators are speed-sensitive, so maintain uniform speed. Do not travel too fast for ground conditions. Bouncing equipment will cause the application rate to vary. Stay out of any dust cloud that may form.

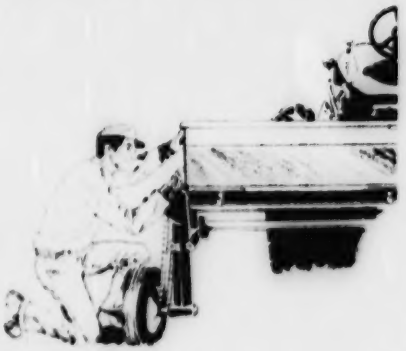
Watch banders to see that band width stays the same. Small height changes due to changing soil conditions may cause rapid changes in band width.

Clean equipment as directed by the operator's manual.

Calibration

Calibration is simply adjusting your equipment to apply the desired rate of pesticide. You need to do this so that you can be sure you are using each pesticide as directed on the label. Too much pesticide is dangerous; too little will not do a good job. Only by calibrating correctly can you safely get the best results.

There are many ways to calibrate equipment. The preferred methods differ according to the kind of equipment used. Your Cooperative Extension agent can show you how to calibrate your equipment. Here is one basic method for sprayers and another for dusters and granular applicators.



Sprayers

To apply a pesticide evenly and accurately, your sprayer must move at a constant speed when in use. It also must be pumping at a constant pressure. Each nozzle must be clean and at the right height. All nozzles must be of the correct type and size. Each nozzle in the system must deliver its rated amount of pesticide.

First, choose the speed, pumping pressure, and nozzles that you want to use. Fill the spray tank with water and operate the sprayer in place to fill the system. Then top off the tank. Spray one acre as if you were applying the pesticide. Measure the amount of water needed to refill your tank. This is your application rate per acre. If it takes 8 gallons to refill the tank, you are spraying at the rate of 8 gallons per acre. If your sprayer has a tank of more than 10 gallons capacity, spray an area large enough to use at least 10 percent of the tank capacity.

If your sprayer is delivering more or less spray than the label directs, you can change the rate three ways:

- You can change the pressure. Lower pressure means less spray delivered; higher pressure means more spray delivered. Pressure change may change the nozzle pattern and droplet size. Pressure must be increased 4 times to double the output.
- You can change the speed of your sprayer. Slower speed means more spray delivered; faster speed means less spray delivered. If you drive half as fast, you double the delivery rate.
- You can change the nozzle tips to change the amount delivered. The larger the hole in the tip, the more spray delivered. This is the best method for making major changes in the delivery rate of sprayers. Always select nozzles for the job you want done. Use the manufacturer's performance charts to make your selection.

After making a pressure, speed, or nozzle change, recalibrate your sprayer to measure its delivery rate.

You now know how many gallons of spray per acre your equipment will apply. Next you must find out how much pesticide to put in the tank to apply the correct dosage of pesticide. To do this you need to know two more facts:

- How much your sprayer tank holds.
- The amount of formulation to be used per acre; this will be listed on the label.

Suppose your tank holds 50 gallons of spray. The directions say to apply one pint of formulation on each acre. In our example, you found that your sprayer applies 8 gallons per acre. First find the number of acres one tank load will spray. Divide 50 gallons by 8.

$$\frac{\textit{50 gallons per tankful}}{\textit{8 gallons per acre}} = \textit{6¼ acres per tankful}$$

Then find the amount of formulation you must add to your tank so you can spray 6¼ acres with one pint per acre. Multiply 1 pint by 6¼.

1 pint per acre × 6¼ acres per tankful
= 6¼ pints per tankful.

Suppose the formulation of a pesticide is a 50 percent wettable powder and you want to apply ½ pound of active ingredient per acre. In our example your tank covers 6¼ acres.

Find how many pounds of formulation are needed to apply ½ pound of active ingredient per acre. There is ½ pound of active ingredient in 1 pound of 50 percent wettable powder formulation.

So you need to use 1 pound of formulation for each acre your sprayer will cover.

1 pound per acre × 6¼ acres per tankful
= 6¼ pounds per tankful.

You should add the 6¼ pounds of wettable powder to a small amount of water in a clean bucket. Stir until it is mixed well and then add this

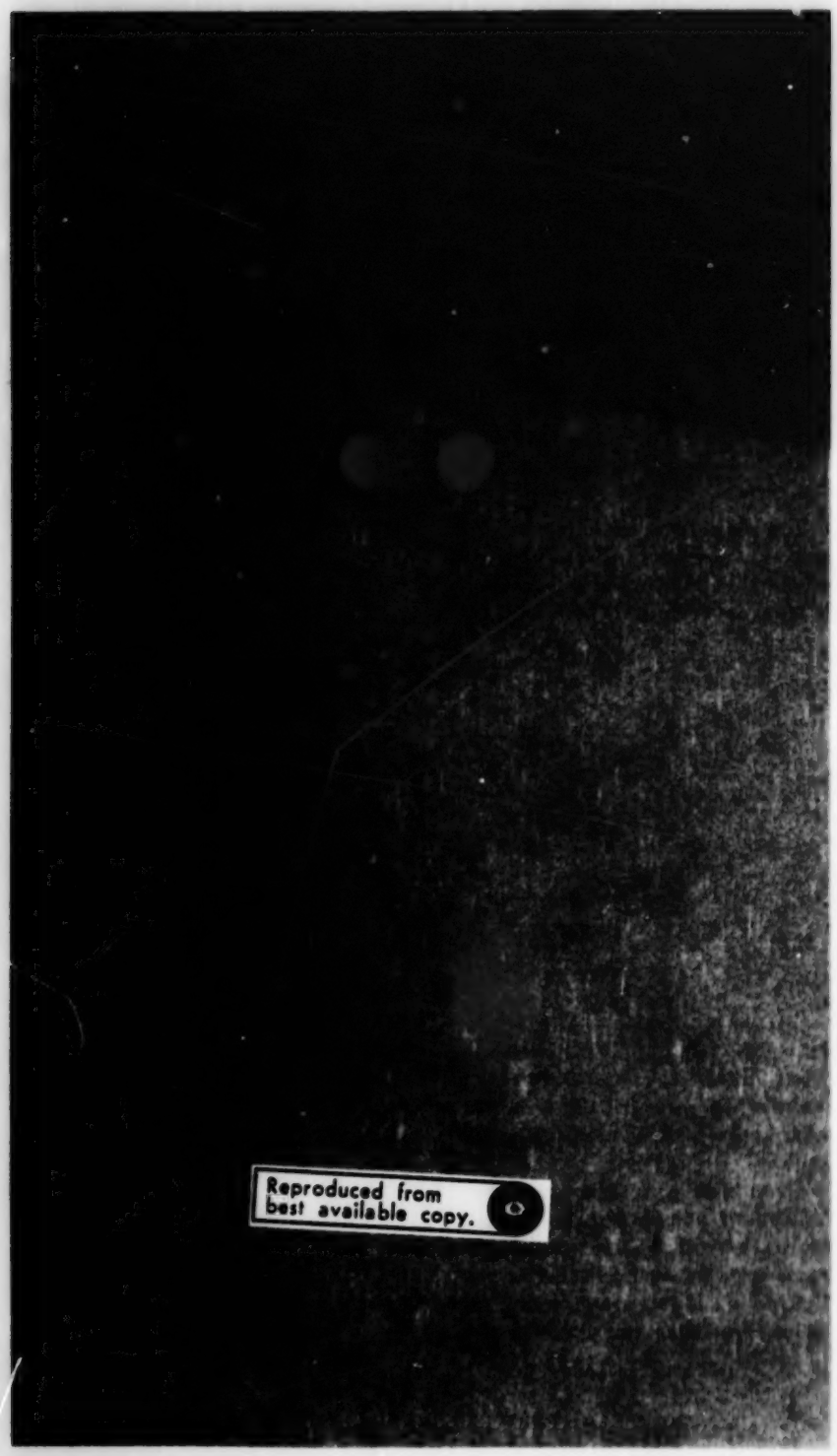
mixture (called a slurry) to the partly filled tank. Remember to operate the sprayer's agitator while adding the mixture and filling the tank.

Even after your sprayer is calibrated, you should recheck it often. Be sure you are spraying the same area for each tankful as you figured on. If you are spraying more or less area than you planned, stop spraying and recalibrate. If you have figured wrong or your sprayer delivery rate changes, you will be able to catch it before you make a major mistake.

Dusters and Granular Applicators

- Read the manufacturer's operator's manual. Follow these instructions to set the gate openings for the product you are going to use.
  Caution: Always set the openings from the same direction, such as from closed to open. This will minimize variations in settings.
- Fill each hopper to an easily determined level.
- Operate the equipment over a measured area or distance at your normal working speed. The area should be at least ¼ acre or 1,000 feet of row.
- Refill the hopper to the same level, carefully weighing the amount of pesticide needed.
- The amount of pesticide it takes to refill the hopper is the amount applied to the measured area or distance. If the amount applied does not fall within 5 percent of the recommended dosage, reset the gate openings and repeat the previous three steps.
- Keep a record of the acreage treated with each filling of the hopper. This will let you see any slight change in rate of application and make the necessary adjustments.

Laws and Regulations



Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as Amended

This is the law which requires you to show that you know the correct way to use and handle pesticides. Here are the parts of the law which concern you:

- It says that all pesticide uses must be *classified* as either general or restricted,
- It requires you to be *certified* as competent to use any of the pesticides classified for restricted use, and
- It provides *penalties* (up to $1,000 and 30 days in prison) for people who do not obey the law.

Residues

The pesticide that stays in or on raw farm products is called a *residue*. The Federal Food, Drug, and Cosmetic Act gives EPA the authority to say what amounts of residue are safe. These amounts are called *tolerances*.

Tolerances are expressed in "parts per million" (ppm). One ppm equals one part (by weight) of pesticide for each million parts of the farm product. Using pounds as a measure, 50 ppm would be 50 pounds of pesticide in a million pounds of the product. The same pesticide may have a different tolerance on different products.

Label instructions take these things into account. They will tell you how many days before harvest the pesticide may be applied. Follow the label exactly.

Other Terms Used in Pest Control

Some of these words have several meanings. Those given here are the ones that relate to pest control.

Abrasion: The process of wearing away by rubbing.

Abscission: The separation of fruit, leaves, or stems from a plant.

Absorption: The process by which a chemical is taken into plants, animals, or minerals. Compare with *adsorption*.

Activator: A chemical added to a pesticide to increase its activity.

Adherence: Sticking to a surface.

Adjuvant: Inert ingredient added to a pesticide formulation to make it work better.

Adsorption: The process by which chemicals are held on the surface of a mineral or soil particle. Compare with *absorption*.

Adulterated: Any pesticide whose strength or purity falls below the quality stated on its label. Also, a food, feed, or product that contains illegal pesticide residues.

Aerobic: Living in air. The opposite of anaerobic.

Aerosol: An extremely fine mist or fog consisting of solid or liquid particles suspended in air. Also, certain formulations used to produce a fine mist.

Agitation: The process of stirring or mixing in a sprayer.

Alkaloids: Chemicals present in some plants. Some are used as pesticides.

Anaerobic: Living in the absence of air. The opposite of aerobic.

Animal Sign: The evidences of an animal's presence in an area.

Antagonism: The loss of activity of a chemical when exposed to another chemical.

Antibiotic: A substance which is used to control pest microorganisms.

Antidote: A practical treatment for poisoning, including first aid.

Aqueous: A term used to indicate the presence of water in a solution.

Arsenicals: Pesticides containing arsenic.

Aseptic: Free of disease-causing organisms.

Bait Shyness: The tendency for rodents, birds, or other pests to avoid a poisoned bait.

Bipyridyliums: A group of synthetic organic pesticides which includes the herbicide paraquat.

Botanical Pesticide: A pesticide made from plants. Also called plant-derived pesticides.

Broadleaf Weeds: Plants with broad, rounded, or flattened leaves.

Brush Control: Control of woody plants.

Carbamate: A synthetic organic pesticide containing carbon, hydrogen, nitrogen, and sulfur.

Carcinogenic: Can cause cancer.

Carrier: The inert liquid or solid material added to an active ingredient to prepare a pesticide formulation.

Causal Organism: The organism (pathogen) that produces a specific disease.

Chemosterilant: A chemical that can prevent reproduction.

Chlorinated Hydrocarbon: A synthetic organic pesticide that contains chlorine, carbon, and hydrogen. Same as organochlorine.

Chlorosis: The yellowing of a plant's green tissue.

Cholinesterase: A chemical catalyst (enzyme) found in animals that helps regulate the activity of nerve impulses.

Compatible: When two or more chemicals can be mixed without affecting each other's properties, they are said to be compatible.

Concentration: The amount of active ingredient in a given volume or weight of formulation.

Contaminate: To make impure or to pollute.

Corrosion: The process of wearing away by chemical means.

Crucifers: Plants belonging to the mustard family, such as mustard, cabbage, turnip, and radish.

Cucurbits: Plants belonging to the gourd family, such as pumpkin, cucumber, and squash.

Deciduous Plants: Perennial plants that lose their leaves during the winter.

Deflocculating Agent: A material added to a suspension to prevent settling.

Degradation: The process by which a chemical is reduced to a less complex form.

Dermal: Of the skin; through or by the skin.

Dermal Toxicity: Ability of a chemical to cause injury when absorbed through the skin.

Diluent: Any liquid or solid material used to dilute or carry an active ingredient.

Dilute: To make thinner by adding water, another liquid, or a solid.

Dispersing Agent: A material that reduces the attraction between particles.

Dormant: State in which growth of seeds or other plant organs stops temporarily.

Dose, Dosage: Quantity of a pesticide applied.

Emulsifier: A chemical which aids in suspending one liquid in another.

Emulsion: A mixture in which one liquid is suspended as tiny drops in another liquid, such as oil in water.

Fungistat: A chemical that keeps fungi from growing.

GPA: Gallons per acre.

GPM: Gallons per minute.

Growth Stages of Cereal Crops: (1) Tillering—when additional shoots are developing from the flower buds. (2) Jointing—when stem internodes begin elongating rapidly. (3) Booting—when upper leaf sheath swells due to the growth of developing spike or panicle. (4) Heading—when seed head is emerging from the upper leaf sheath.

Hard (water): Water containing soluble salts of calcium and magnesium and sometimes iron.

Herbaceous Plant: A plant that does not develop woody tissue.

Host: The living plant or animal a pest depends on for survival.

Hydrogen-Ion Concentration: A measure of acidity or alkalinity, expressed in terms of the pH of the solution. For example, a pH of 7 is neutral, from 1 to 7 is acid, and from 7 to 14 is alkaline.

Immune: Not susceptible to a disease or poison.

Impermeable: Cannot be penetrated. Semipermeable means that some substances can pass through and others cannot.

Lactation: The production of milk by an animal, or the period during which an animal is producing milk.

Larva: The early form of an insect from the time that it leaves the egg until it becomes a pupa.

LC50: The concentration of an active ingredient in air which is expected to cause death in 50 percent of the test animals so treated. A means of expressing the toxicity of a compound present in air as dust, mist, gas, or vapor. It is generally expressed as micrograms per liter as a dust or mist but in the case of a gas or vapor as parts per million (ppm).

LD50: The dose of an active ingredient taken by mouth or absorbed by the skin which is expected to cause death in 50 percent of the test animals so treated. If a chemical has an LD50 of 10 milligrams per kilogram (mg/kg) it is more toxic than one having an LD50 of 100 mg/kg.

Leaching: Movement of a substance downward or out of the soil as the result of water movement.

Mammals: Warm-blooded animals that nourish their young with milk. Their skin is more or less covered with hair.

Metamorphosis: A change in shape, form, and size in insects.

Miscible Liquids: Two or more liquids that can be mixed and will remain mixed under normal conditions.

MPH: Miles per hour.

Mutagenic: Can produce genetic change.

Necrosis: Localized death of living tissue such as the death of a certain area of a leaf.

Necrotic: Showing varying degrees of dead areas or spots.

Nitrophenols: Synthetic organic pesticides containing carbon, hydrogen, nitrogen, and oxygen.

Noxious Weed: A plant defined as being especially undesirable or troublesome.

Nymph: The stage of development in certain insects after hatching. They look like the adult but lack fully developed wings.

Oral: Of the mouth; through or by the mouth.

Oral Toxicity: Ability of a pesticide to cause injury when taken by mouth.

Organic Compounds: Chemicals that contain carbon.

Organochlorine: Same as chlorinated hydrocarbon.

Organophosphate: A synthetic organic pesticide containing carbon, hydrogen, and phosphorus; parathion and malathion are two examples.

Ovicide: A chemical that destroys eggs.

Parasite: A plant or animal that lives on or in another plant or animal from which it gets food.

Pathogen: Any disease-producing organism.

Penetration: The act of entering or ability to enter.

Pest: Living things that compete with man for food and fiber, or attack man directly.

Phytotoxic: Harmful to plants.

Pollutant: An agent or chemical that makes something impure or dirty.

PPB: Parts per billion. A way to express the concentration of chemicals in foods, plants, and animals. One part per billion equals 1 pound in 500,000 tons.

PPM: Parts per million. A way to express the concentration of chemicals in foods, plants, and animals. One part per million equals 1 pound in 500 tons.

Predator: An animal that destroys or eats other animals.

Propellant: Liquid in self-pressurized pesticide products that forces the active ingredient from the container.

PSI: Pounds per square inch.

Pubescent: Having hairy leaves or stems.

Pupa: The stage between the larva and adult in the development of some insects.

Respiratory Tract: Having to do with or used for breathing; the lungs and other parts of the breathing system.

Rhizome: A rootlike underground stem.

RPM: Revolutions per minute.

Safener: A chemical added to a pesticide to keep it from injuring plants.

Seed Protectant: A chemical applied to seed before planting to protect seeds and new seedlings from disease and insects.

Soil Sterilant: A chemical that prevents the growth of all plants and animals in the soil. Soil sterilization may be temporary or permanent, depending on the chemical.

Soluble: Will dissolve in a liquid.

Solution: Mixture of one or more substances in another in which all ingredients are completely dissolved.

Solvent: A liquid which will dissolve a substance to form a solution.

Spreader: A chemical which increases the area that a given volume of liquid will cover on a solid or on another liquid.

Sticker: A material added to a pesticide to increase its adherence.

Stolon: An above-ground stem that produces roots.

Surfactant: A chemical which increases the emulsifying, dispersing, spreading, and wetting properties of a pesticide product.

Susceptible: Capable of being diseased or poisoned; not immune.

Susceptible Species: A plant or animal that is poisoned by moderate amounts of a pesticide.

Suspension: Finely divided solid particles mixed in a liquid.

Synergism: The joint action of two or more pesticides that is greater than the sum of their activity when used alone.

Target Pest: The pest at which a particular pesticide or other control method is directed.

Tolerance: (1) The ability of a living thing to withstand adverse conditions, such as pest attacks, weather extremes, or pesticides. (2) The amount of pesticide that may safely remain in or on raw farm products at time of sale.

Toxicant: A poisonous chemical.

Trade Name: Same as brand name.

Vapor Pressure: The property which causes a chemical to evaporate. The lower the vapor pressure, the more easily it will evaporate.

Vector: A carrier, such as an insect, that transmits a pathogen.

Viscosity: A property of liquids that determines whether they flow readily. Viscosity usually increases when temperature decreases.

Volatile: Evaporates at ordinary temperatures when exposed to air.

Wetting Agent: A chemical which causes a liquid to contact surfaces more thoroughly.

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Weights and Measures

Weights
16 ounces = 1 pound
1 gallon water = 8.34 pounds

Liquid Measure
1 fluid ounce = 2 tablespoons
16 fluid ounces = 1 pint
2 pints = 1 quart
8 pints = 4 quarts = 1 gallon

Length
3 feet = 1 yard
16 ½ feet = 1 rod
5,280 feet = 320 rods = 1 mile

Area
9 square feet = 1 square yard
43,560 square feet = 160 square rods = 1 acre

Speed
1.466 feet per second = 88 feet per minute = 1 mph

Volume
27 cubic feet = 1 cubic yard